WINDROW COMPOSTING MANURE

CONSERVATION INFORMATION SHEET - Agronomy Series 317

Natural Resources Conservation Service

Michigan

Windrow Composting Before

Windrow Composting After

What Is Composting?

Composting is a naturally occurring aerobic process where organic materials such as livestock manure, spoiled waste feed, straw or sawdust bedding, spoiled hay, leaves, nitrogen, and other carbonaceous materials are converted by micro-organisms into stable organic material. Composting is accomplished by controlling carbon, nitrogen, moisture, fresh air content, and temperature to manage the speed of the process.

Why Compost Manure

Several benefits to composting manure include:

- Reduced investment/cost for storage of manure.
- Reduced manure volume by 60 percent or more; i.e., less water and cheaper to haul. It is also stable, so it can be hauled at a convenient time.
- Reduced potential loss of nitrogen and phosphorus via runoff, leaching, and volatilization of nitrogen gases.
- Better conservation of nutrients for future use.
- Less odor than raw manure.
- Fewer viable weed seeds returned to the field.
- A new value-added commodity to improve farm income by selling directly to consumers.
- Improved soil quality and health.

Considerations

Physical Considerations

To be successful at windrow composting of livestock manure, consider the following:

1. Is there enough area available on the farm to locate a site to make windrows.
2. Is there a dependable and plentiful carbon source and other needed materials.
3. Is there available equipment and time to properly build and manage composting windrows.
4. Are there well drained soils capable of supporting a good sod cover for the compost site.
5. Grassed sites should have a uniform 2-5 percent slope, without a cross slope. Windrows should be made parallel to the slope so runoff can flow away from the windrow site. Keep in mind that when using "in field sites," it is best to have two locations that can be alternately used.
6. Permanent sites should have a stable base of compacted road gravel, crushed limestone, asphalt, or concrete designed for the equipment size and weight loads.
7. Can runoff be contained on the farm in a grassed settling or infiltration area.
8. Starting compost bulk density weight should be between 35-40 pounds/cubic foot. Following is one method to determine if the compost is suited for aeration: if the starting compost weight is above 40 pounds/cubic foot, some carbon (bulking) source such as straw, dry hay, sawdust, or wood chips can be added to the windrow to reduce bulk density and improve aeration.

Composting Process

Windrow management is gained by experience. The following activities are important to successfully compost livestock manure in 2 months or more:

1. Optimum windrow shape is slightly rounded (see picture) with an 8-10 foot base and a 4-5 foot height. Larger windrows tend to have a surface to volume ratio less suitable for gas exchange and proper turning (aerating) of the windrow.
2. Windrows should have an initial carbon to nitrogen (C:N) ratio of 25-30:1. As a comparison, this is approximately equivalent to two parts straw bedding to one part dairy manure. A low C:N ratio will result in a greater loss of nitrogen as ammonia (more odor). A high C:N ratio will starve microbes and slow the composting process.
3. Starting moisture content should be between 55-65 percent and maintained at no less than 45 percent.
4. The windrow process requires that it be turned on a regular basis. There are numerous types of equipment that will invert, fluff, and expose the windrow to fresh air (oxygen), then rebuild the windrow to its original shape.
5. Windrows may also be turned with a front-end loader or skid steer. Space windrows to accommodate turning equipment.
6. Rule of thumb for turning windrows is as follows: once every week or every 5 days at first. Less turning is okay, but will probably take longer to produce compost.
7. Indicators that can be used to more specifically determine turning needs include CO_2 and temperature. Both of these indicators are a direct result of a healthy microbial population functioning properly.
8. When monitoring for CO_2, levels are measured daily by using volumetric displacement instruments. This type of measurement is usually used when producing a specific, higher quality end product. The windrows are turned when the CO_2 levels exceed 10 percent. This level is an indirect estimate of available oxygen in the windrow.
9. When the internal temperature of a windrow reaches 140^{o}F, it is ready to turn. Three days at this temperature are usually sufficient to kill most weed seeds, as well as numerous pathogens.

10. To improve moisture control during the composting process, windrows not under a roof should be covered with a non-woven geo-textile fleece. The fleece is designed to shed rain but allow for the free exchange of CO_2 and oxygen. If the moisture content falls below 45 percent, add water to the windrow or remove the blanket to collect rainfall.
11. The composting process can be completed in 8-12 weeks depending on the initial C:N ratio, the carbon source used, moisture, and the frequency of turning.
12. It is generally recommended that the finished product be allowed to cure for one month after ambient temperature is reached in the compost.

Finished Compost Product

Finished products vary in quality depending on the materials utilized, management intensity, and the intended end use of the product. Finished compost generally has the following characteristics:

- Heating ceases as a result of decreased microbial activity.
- It is dark brown to black in color.
- Original windrow components are indistinguishable.
- It has an earthy odor comparable to a forest soil.
- pH is close to neutral (6-8).
- C:N ratio is 11-13:1.
- Finished product is not phytotoxic (detrimental to plants).

Worksheets for designing and sizing a compost area are available in the Appendix of the On-Farm Composting Handbook, NRAES-54.

References

Cavigelli, M.A., S.R. Deming, L.K. Probyn, and R.R. Harwood (eds.), 1998. Michigan Field Crop Ecology: Managing Biological Processes for Productivity and Environmental Quality. Michigan State University-Extension Bulletin E-2646, 92 pp.

Lehnert, R.H., J.C. Durling, and C.S. Lufkin (eds), 2000. Composting on Michigan Farms. Michigan State University-Extension Bulletin E-2715, 27 pp.

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CHARACTERISTICS OF SELECTED MATERIALS USED FOR ON-FARM WINDROW COMPOSTING

Material	Type of Value	Percent Nitrogen (dry weight)	C:N Ratio (weight:weight)	Percent Moisture (wet weight)	Bulk Density lb./cu. ft.
BEDDING and BULKING (CARBON SOURCE)					
Corn stalks	Typical	0.6-0.8	60-73	12	1.2
Hay - legume	Range	1.8-3.6	15-19	8-10	-
	Average	2.5	16	-	-
Hay - grass	Range	0.7-2.5	-	8-10	-
	Average	1.3	32	-	-
Straw - oat	Range	0.6-1.1	48-98	4-27	2.1-14
	Average	0.9	60	12	8.4
Straw - wheat	Range	0.3-0.5	100-150	4-26	2.1-14
	Average	0.4	127	12	8.4
Saw dust (@ mill)	Range	0.06-0.8	200-750	19-65	13-16.7
	Average	0.24	442	39	15.2
Hardwood (dry)	Range	0.06-0.11	415-819	-	16.5-23
(chips, shavings, etc.)	Average	0.09	560	8	-
Softwood (dry)	Range	0.04-0.23	212-1,313	-	16.5-23
(chips, shavings, etc.)	Average	0.09	641	12	-
Leaves	Range	0.5-1.3	40-80	-	-
	Average	0.9	54	38	-
loose, dry	Typical	-	-	-	3.7-11
compacted, wet	Typical	-	-	-	14.8-18.5
Tree trimmings	Typical	3.1	16	70	48
MANURES and OTHER NITROGEN SOURCES					
Cattle	Range	1.5-4.2	11-30	67-87	49-62
	Average	2.4	19	81	54
dairy-tie stall	Typical	2.7	18	79	-
dairy-free stall	Typical	3.7	13	83	-
Swine	Range	1.9-4.3	9-19	65-91	-
	Average	3.1	14	80	-
Turkey litter	Average	2.6	16	26	29
Laying hens	Range	4-10	3-10	62-75	51-60
	Average	8.0	6	69	54.8
Grass clippings **	Range	2.0-6.0	9-25	-	-
	Average	3.4	17	82	-
loose	Typical	-	-	-	11.1-14.8
compacted	Typical	-	-	-	18.5-29.6

This data is derived from Bulletin NRAES-54, On-Farm Composting Handbook. A variety of sources are referenced and, where numerous values are available, ranges and averages are given. *Values should not be considered absolutes, but rather representative.*

** Green grass clippings should always be treated as a nitrogen source, and NOT a carbon source.